FAINT X-RAY SOURCES IN THE GALACTIC CENTRE

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ABSTRACT

We study the population of X-ray binaries in the Galactic Centre (GC). The observed population (Muno et al. 2003) consists of ∼2000 faint sources. Wind-fed NS binaries (Pfahl et al. 2002) and quiescent RLOF NS/BH transients (Belczynski & Taam 2004) have been studied via population synthesis methods as possible candidates for this XRB population, though these systems are not numerous enough in order to account for the observations. Muno et al. (2004) proposed that intermediate polars may be able to explain the GC population of faint X-ray point sources. We extend the population synthesis studies previously undertaken for NS and BH XRBs to include the population of intermediate polars, and calculate the GC XRB population. Our calculations produce about 2000 intermediate polars with X-ray luminosities between $10^{31} - 10^{33}$ erg/s. It is found that the faint, hard X-ray point sources in the GC can be explained by intermediate polars.

Key words: Galactic Centre; X-ray binaries; white dwarfs.

1. INTRODUCTION

An X-ray survey of the Galactic Centre (GC) with the ACIS-I on Chandra (Wang et al. 2002) first revealed the presence of of ∼1000 spectrally hard X-ray sources ($2-8$ keV). A deeper Chandra survey (see Muno et al. 2003) revealed 2357 X-ray point sources, ∼1800 of which are detected within the hard Chandra band. It has been hypothesized that wind-fed neutron star accretors with high- and intermediate-mass companions (Pfahl et al. 2002) or RLOF NS/BH binaries (Belczynski & Taam 2004) may be responsible for the GC population. However, population synthesis studies have shown that these systems are not abundant enough to be responsible for the entire observed GC population. Muno et al. (2004) suggested that the observed faint sources are likely accreting white dwarf (WD) binaries. Intermediate Polars (IPs), which involve a magnetic accreting white dwarf, and usually a main sequence (MS) or evolved companion, are the most luminous subclass of Cataclysmic Variables in the X-ray band. In our study we model the number of IPs and their X-ray luminosities in the GC. All different types of IPs are considered: WD-WD, WD-MS and WD-evolved companions, but we select only systems which are bright enough to make the Muno ($2-8$ keV) X-ray luminosity threshold of 10^{31} erg/s.

2. MODEL DESCRIPTION

Our study has been carried out using the population synthesis code *StarTrack* (Belczynski et al. 2002; Belczynski et al. 2005, in prep). Stars are evolved with the metallicity and wind-mass-loss dependent stellar models as described in Belczynski et al. (2002) which incorporate physical processes important for binary evolution, such as magnetic braking, tidal interactions, detailed mass transfer calculations and gravitational radiation. All single and binary stars are evolved from the ZAMS and pass through the following phase sequence: Main Sequence, Hertzsprung Gap, Red Giant Branch, core He Burning, Asymptotic Giant Branch. Also, evolution of Helium stars is followed in detail. We assume that the IP X-ray luminosity is a function of the accretion rate, accreting WD physical properties, and the efficiency with which the accretion luminosity is converted to hard X-ray luminosity in the Chandra band. We also take into account non-symmetric X-ray emission from IPs. For further details on the IP X-ray luminosity model, see Ruiter et al. 2005 (in prep). We then assign a fraction of CV systems (any RLOF system with a WD accretor) that are intermediate polars (subclass of magnetic WD accretors); our standard model uses an IP fraction of 5% (Kube et al. 2003). The stellar population of the GC is evolved through 10 Gyr and all IP systems are extracted and their luminosities and numbers are compared to those of the Muno survey.

Table 1. Galactic Centre numbers of synthetic intermediate polar systems. Observed number of sources in GC is ~ 2000 (Muno et al. 2003)

IP type in GC	IP frac. 1%	IP frac. 5%	IP frac. 20%
WD-MS	361	1804	7220
WD-Evolved	3	14	58
WD-WD	28	140	563
Total	392	1958	7841

3. RESULTS/CONCLUSIONS

We find that the number of synthetic IP systems predicted by our model for the Galactic Centre depends strongly on the IP fraction. The number of systems with X-ray luminosities within the Muno survey ($> 10^{31}$ erg/s) is found within the range $400 - 8000$ (see Table 1). However, for our standard model IP fraction of 5% we find $\sim$2000 IPs. In Table 1 we also show the types of different IPs formed in our simulations. The most frequent type is a magnetic WD accreting from a low mass MS star ($< 1 M_{\odot}$). Such systems are too faint to be detected in the ongoing infrared search for counterparts of GC faint X-ray sources (Bandyopadhyay et al. 2005). In Figure 1 we show the luminosity distribution of synthetic IPs (left panel), and a corresponding X-ray luminosity function for the population (right panel). It is noted that only 40% of IPs are bright enough to make the Muno survey X-ray luminosity threshold: we show these systems with the solid line. For comparison we also show the entire synthetic IP population with a dotted line. It is noted that the power-law slope of the X-ray luminosity function for IPs corresponding to the Muno survey is $\sim$0.9. We have studied the physical properties of the IP population, most of which are magnetic WDs accreting from low-mass MS stars. Based on the full population synthesis calculation for the GC we conclude that the faint X-ray sources found in the Muno et al. survey may be explained by the model population of IPs.

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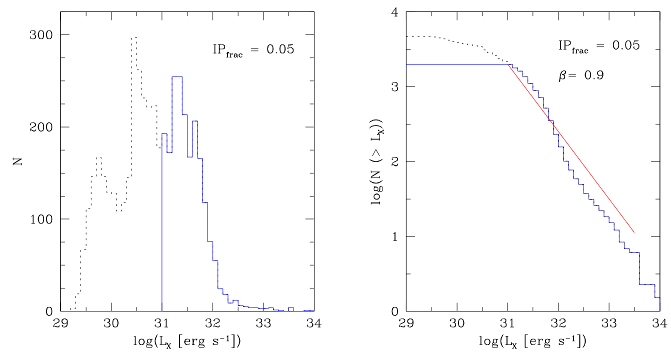

Figure 1. Left: luminosity distribution of synthetic IP systems in the Galactic Centre for the model with an IP fraction of 0.05. Right: corresponding X-ray luminosity function (XLF). The entire IP population is shown with a dotted line, while a subset of these, the IPs corresponding to the Muno et al. survey, are shown with an overlaid solid line (for this we also show the power law slope of the XLF with a solid line).

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